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(12) EUROPEAN PATENT APPLICATION

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(54) A stream selector for a process analyzer.

(57) In one aspect the invention provides a valve module (33) for a process analyzer. The module includes a first block valve (33b) having a first opening, a second block valve (33c) having a second opening and a bleed valve (33d) having a third opening. The first and second block valves are made so that both are closed or both open at the same time. The block valves and the bleed valve are made so that, in a first mode, the block valves are closed and the bleed valve is open ; in a second mode, the block valves are open and the bleed valve is closed ; and in a third mode, all of the valves are open, thereby ensuring that the module is completely purged. In a second aspect the invention provides a stream-selection valve manifold. The manifold (2a) is made by joining two or more valve modules (33) side by side to form a common outlet passageway (18) and a common vent passageway (17), thereby ensuring that the manifold is completely purged. In a third aspect the invention provides a single block-and-bleed valve module (79). The module includes a block valve, a sample-fluid compartment (52), a vent compartment (53), an internal pneumatic actuator (63), an actuator compartment (64), a sample-inlet first passageway (54), a sample-outlet second passageway (55), a third passageway (65) for introducing a compressed gas into the actuator compartment, a fluid-disposal fourth passageway (76), a spring (62) for closing the block valve, a compressed gas for opening the valve, and a body (51) for containing the modular components. The fluid-disposal passageway (76) provides fluid communication between the vent compartment (53) and an external area suitable for the safe disposal of sample fluids and compressed gas contained in the valve module. The pressure within the vent compartment and the disposal passageway is normally kept equal to or lower than that of the sample-inlet passageway, sample-outlet passageway, and actuator compartment, in order to prevent fugitive emission of the sample fluid or the compressed gas from the module into the external environment. The flat-face sealing structure (71) of each valve is very tolerant of scratching and/or irregularities in the sealing structure and of abrasive particulates which may be present in the sample fluid, and even of minor structural damage to the sealing structure.

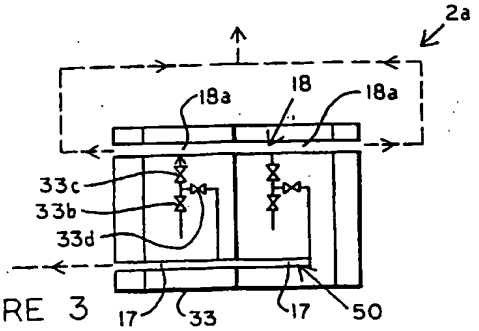

FIGURE 3

EP 0 583 166 A2

a first mode, the block valves are closed and the bleed valve is open; in a second mode the block valves are open and the bleed valve is closed; and in a third mode, all of the valves are open, thereby ensuring that the module is completely purged.

The valve module further comprises flat-face sealing means for closing the valves by pressing the sealing means against a flat sealing surface, and for opening the valves by breaking contact between the sealing means and the flat sealing surface.

In a second aspect the present invention provides a stream-selection valve manifold. The valve manifold comprises first and second valve modules joined side by side to form a common outlet passageway and a common vent passageway. Each valve module includes two block valves and a bleed valve. The block valves are so constructed and arranged that both are closed simultaneously or both are open simultaneously. The three valves are so constructed and arranged that, in a first mode, the block valves are closed and the bleed valve is open; in a second mode, the block valves are open and the bleed valve is closed; and in a third mode, all three valves are open, thereby ensuring that the module is completely purged.

Each valve module further comprises flat-face sealing means for closing the valves by pressing the sealing means against a flat sealing surface, and for opening the valves by breaking contact between the sealing means and the flat sealing surface. One of the block valves communicates with an inlet passageway. The other block valve communicates with an outlet passageway. The bleed valve communicates with a vent passageway. Flow-through means hold the first and second valve modules in a fixed configuration wherein the outlet passageways of the first and second valve modules are aligned to form a common outlet passageway to and through the flow-through holding means, and the vent passageways from the first and second valve modules are aligned to form a common vent passageway, thereby ensuring that the manifold is completely purged.

In a third aspect, the invention provides a single block-and-bleed valve module. The module comprises a block valve, a sample-fluid compartment, a vent compartment, an internal pneumatic actuator, a sample-inlet first passageway, a sample-outlet second passageway, third and fourth passageways, first biasing means for closing the block valve, second biasing means for opening the valve, and a body having a cavity therein for housing the block valve, the sample-fluid compartment, the vent compartment, the pneumatic actuator, and the first, second, third, and fourth passageways.

The internal pneumatic actuator includes an actuator piston and an actuator compartment. The actuator compartment is constructed and arranged to receive compressed gas from an external source.

The first biasing means close the block valve by urging the piston in a first direction. The second biasing means, which include a compressed gas, open the valve by urging the piston in a second direction.

The block valve is so constructed and arranged that, when closed, fluid communication is blocked between the inlet passageway and the sample-fluid compartment; when open, the inlet passageway, the sample-fluid compartment, and the outlet passageway are in fluid communication.

The inlet passageway provides means for fluid communication from the external environment to the sample-fluid compartment. The outlet passageway provides means for fluid communication from the sample-fluid compartment to the external environment. The third passageway provides means for introducing a compressed gas into the actuator compartment. The fourth passageway provides means for fluid communication between the vent compartment and an external area suitable for the safe disposal of fluids contained within the valve module. The pressure within the vent compartment and the fourth passageway is normally maintained at a level equal to or lower than that of the sample-fluid compartment, the sample-inlet passageway, the sample-outlet passageway, and the actuator compartment, in order to prevent fugitive emission of the sample fluid or of the compressed gas from the module into unprotected areas of the external environment. Compressed fluid (compressed gas or liquid) may be used as the second biasing means.

Non-limiting embodiments of the invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 is a schematic representation of a second embodiment of a stream-selection valve manifold for a process analyzer, made in accordance with the principles of the present invention.

Figure 2 is a schematic representation of a shutoff and atmospheric reference vent for a process gas chromatograph, made in accordance with the principles of the present invention.

Figure 3 is a schematic representation of a first embodiment of a stream-selection valve manifold for a process analyzer, made in accordance with the principles of the present invention.

Figure 4 is an isometric view of the stream-selection valve manifold shown schematically in Figure 3.

Figure 5 is an isometric view of the shutoff and atmospheric reference vent shown in Figure 2.

Figure 6 is an isometric view of the second embodiment of a stream-selection valve manifold for a process analyzer shown schematically in Figure 1.

Figure 7 is a cross-sectional view of the valve manifold shown in Figure 4, taken along the cutting line 7-7.

Figure 8 is a cross-sectional view of the valve

on a Shore "A" gauge, and the depth of the grooves 29a and 29b is from about eighty-seven to about ninety-one percent of the width of the O-rings 12 and 12b, respectively.

The valve poppet 15 is normally maintained in the extreme lower position (Figure 7) by the downward force of the compression return spring 3 applied to the poppet stem 15a via an actuator washer 5, actuator piston 9, and an E-ring 4b.

A second compartment 39 comprises the middle portion of the cavity 26. The second compartment 39 is formed by the upper flat surface of the seal-plug top part 11 and the lower flat surface of the piston 9. When the second compartment 39 is pressurized by an external pneumatic source (not shown) of sufficient pressure via a passageway 23, an upward force resulting from the pneumatic pressure applied to the lower surface of the piston 9 overcomes the downward force applied by the compression return spring 3, and lifts the poppet 15 to its extreme upper position (Figure 9). The poppet 15 is in the intermediate position shown in Figure 10 for only a very short period of time while in transit between the two extreme positions.

O-rings 6b and 12c provide a dynamic seal between the plug-seal top part 11 and the poppet stem 15a, thereby ensuring fluid isolation at any position of the stem 15a between the passageway 28 and the second compartment 39.

The piston 9 and washer 5 are axially disposed and retained on the upper portion 15ab of the poppet 15 by E-rings 4a and 4b. The O-ring 6a, retained by the washer 5 and axially disposed in a third compartment 26a formed by the upper surface of the piston 9 and the lower surface of the washer 5, provides fluid isolation between the second compartment 39 and a fourth compartment 32, in which the spring 3 is disposed, and which is referenced to (equilibrated with) the atmosphere. The fourth compartment 32 is formed by the lower surface of a cover 2 and the upper surface of the washer 5. An O-ring 7 provides a dynamic seal between the piston 9 and the inside wall of the cavity 26. The cover 2, held to the top 16a of the body 16 by screws 1a and 1b, retains compression spring 3 (Figure 7).

In a second embodiment (Figures 3, 4 and 8), the present invention provides a stream-selection valve manifold 2a for a process analyzer. The manifold 2a comprises: (a) a plurality of pneumatic valve modules 33 joined side-by-side, (b) first and second end plates 4c and 4d, and (c) first and second mounting brackets 40a and 40b. The passageway 18a in each valve module 33 is in alignment with the passageways 18a of adjacent valve modules 33 in the manifold 2a. The first and second end plates 4c and 4d, which are in fluid communication with the passageways 18a of adjacent modules 33, provide means for external fluid communication to a single common passageway 18 formed by the outlet passageways 18a of the individual modules 33.

An O-ring 12d (Figure 8) in a gland 18aa at the end of each module's passageway 18a provides a fluid seal with the passageway 18a of adjacent modules 33 and/or the end plates 4c, 4d. The passageways 17 in the valve modules 33 are joined and sealed with an O-ring 12e in a gland 17a to form a common vent passageway 36 which terminates as a threaded opening 50 in the end plate 4c. The passageway 17 is closed at the end plate 4d by an O-ring 17b in a gland 48b (Figures 3 and 8).

Mounting is facilitated by the use of mounting brackets 40a and 40b (Figures 4 and 8). The entire manifold 2a is held together by threaded rods 41a and nuts 41b. By loosening a first nut 41b at one end of a first threaded rod 41a, a valve module 33 can be removed by rotating it along a path 100 from a first point 100a to to a second point 100b about the first threaded rod 41a disposed in a first slot 45. (Figure 11.) After the valve module 33 has been rotated sufficiently (100b) to clear a second slot 42 from a second threaded rod 41a disposed in a second slot 42, the module 33 can be removed from the manifold 2a. (Figures 4 and 11.) When a module 33 is thus removed, the remaining modules 33 and the end plates 4c, 4d remain assembled. Thus the construction of the manifold 2a permits rapid replacement of one or more of the valve modules 33 in the field.

The passageways 18a of the individual valve modules form a common passageway 18 (Figures 1 and 3) to an analyzer (not shown). This common passageway 18 occupies a very small volume, and is easy to purge out. The passageway 18 is straight and smooth, has a regular surface, and has no "dead volume" or empty space, thereby significantly reducing the time required for sample flow (purging) before all residual fluid from a previously-selected sample stream is displaced. In a preferred embodiment, the width of the passageway 18 is from about 0.06" to about 0.08". The volume of each passageway 18a in each valve module 33 is from about 0.06 to about 0.08 cubic centimeters; yet the passageways 18a and 18 are not restrictive of fluid flow. The valve module C_v is 0.05. The passageways 18a are located in very close proximity to the outlet valves 33c. The passageway 30, which connects the outlet valve 33c to the passageway 18a, is preferably from about 0.045" to about 0.055" in length. (Figures 7, 9, and 10.) The passageway 18a has no "dead" or unpurged space; hence it purges out cleanly and quickly when serving as a conduit for fluid communication in the manifold 2a. (Figure 8.) Internal passageways 36 and 47 (Figure 8) of the end plates 4c and 4d, respectively, are also approximately 0.07" in width, and are also constructed without "dead" or unpurged space. Hence the common passageway 18 servicing the entire manifold 2a has a very small volume and no dead

able for the safe disposal of sample fluids contained within the sample-fluid compartment 52. Pressure within the passageway 76 and the compartment 53 is normally maintained at a level equal to or lower than than that of the sample-fluid compartment 52, the passageway 54, the passageway 55, and the compartment 64.

The O-rings 72, 73, and 74 provide fluid sealing between the compartments 52, 53, 64, and 75. Should the O-ring 72 fail, resulting in sample fluid from the sample-fluid compartment 52 entering the vent compartment 53, the passageway 76 will conduct this fluid to the safe-disposal area referred to above.

In a similar manner, pneumatic-supply gas entering the vent compartment 53 as a result of breaching the O-ring 73, should that O-ring fail, would also be conducted to the external safe-disposal area in fluid communication with the passageway 76.

These characteristics provide a "bleed" feature which ensures that there will not be fugitive emission of sample fluids or pneumatic gas from the valve module 79 to contaminate the surrounding atmosphere, thereby providing a solution to this problem which has continued to plague the prior art.

Mounting holes 77 and 78 provide convenient means for mounting the valve module 51.

The flat-face sealing structure of each valve is very tolerant of scratching of and/or irregularities in the sealing means, of abrasive particulates which may be present in the sample fluid, and even of minor structural damage to the sealing means.

While certain specific embodiments and details have been described in order to illustrate the present invention, it will be apparent to those skilled in the art that many modifications can be made therein without departing from the invention.

Claims

1. A block-and-bleed valve module, comprising:
   (a) a first block valve having a first opening;
   (b) a second block valve having a second opening; the first and second block valves being so constructed and arranged that both are closed simultaneously or both are open simultaneously;
   (c) a bleed valve having a third opening, the bleed valve forming a junction with the first and second block valves and communicating therewith;
   the block valves and the bleed valve being so constructed and arranged that: in a first mode, the block valves are closed and the bleed valve is open; in a second mode, the block valves are open and the bleed valve is closed; and in a third mode, all of the valves are open;
   (d) flat-face sealing means for closing the valves by pressing the sealing means against a flat sealing surface, and for opening the valves by breaking contact between the sealing means and the flat sealing surface;
   (e) means for urging the sealing means against the flat sealing surface to close the valves; and
   (f) means for breaking contact between the sealing means and the sealing surface to open the valves.

2. The valve module of claim 1, wherein the means for urging the sealing means against the sealing surface and for breaking contact between the sealing means and the sealing surface include a valve poppet and an internal pneumatic actuator.

3. The valve module of claim 2, wherein the pneumatic actuator comprises:
   (g) first biasing means for urging the poppet in a first direction, to seal the openings of the block valves while leaving the bleed valve open, thereby placing the valve module in the first mode; and
   (h) second biasing means for urging the poppet in a second direction, to seal the opening of the bleed valve while opening the first and second block valves, thereby placing the valve module in the second mode;
   the third mode being momentarily formed in transit between the first to the second mode, or in transit between the second to the first mode.

4. The valve module of claim 3, wherein the first biasing means include a compression spring, and the second biasing means include a compressed gas.

5. The valve module of claim 3, wherein the first and second biasing means include a compressed gas.

6. The valve module of claim 4, further comprising:
   (i) a body having an inlet port, an outlet port, and a vent port for the first block valve, second block valve, and bleed valve, respectively, the body being constructed and arranged to house the pneumatic actuator and the valves in a cavity within the body.

7. The valve module of claim 6, wherein the body cavity comprises:
   (j) a first portion extending from the lower end of the cavity to the lower surface of a seal-plug bottom part;
   (k) a second portion extending from the upper

first bleed valve is open; in a second mode, the first and second block valves are open and the first bleed valve is closed; and in a third mode, the first and second block valves and the first bleed valve are open;

(a_4) flat-face sealing means for closing the valves by pressing the sealing means against a flat sealing surface, and for opening the valves by breaking contact between the sealing means and the sealing surface;

(a_5) means for urging the sealing means against the sealing surface to close the valves;;

(a_6) means for breaking contact between the sealing means and the sealing surface to open the valves;

(a_7) a first inlet passageway for the first block valve;

(a_8) a first outlet passageway for the second block valve; and

(a_9) a first vent passageway for the first bleed valve;

(b) a second valve module comprising

(b_1) a third block valve having a fourth opening

(b_2) a fourth block valve having a fifth opening;

the third and fourth block valves being so constructed and arranged that both valves are closed simultaneous or both are open simultaneously;

(b_3) a second bleed valve having a sixth opening, the second bleed valve forming a junction with the third and fourth block valves and communicating therewith;

the third and fourth block valves and the second bleed valve being so constructed and arranged that: in a first mode, the third and fourth block valves are closed and the second bleed valve is open; in a second mode, the third and fourth block valves are open and the second bleed valve is closed; and in a third mode, the third and fourth block valves and the second bleed valve are open;

(b_4) flat-face sealing means for closing the valves by pressing the sealing means against a flat sealing surface, and for opening the valves by breaking contact between the sealing means and the sealing surface;

(b_5) means for urging the sealing means against the sealing surface to close the valves;

(b_6) means for breaking contact between the sealing means and the sealing surface to open the valves;

(b_7) a second inlet passageway for the third block valve;

(b_8) a second outlet passageway for the fourth block valve; and

(b_9) a second vent passageway for the second bleed valve;

(c) flow-through means for holding the first and second valve modules in a fixed configuration wherein

(d) the first and second valve modules are joined side-by-side;

(e) the first and second outlet passageways are aligned to form a common outlet passageway to and through the flow-through holding means; and

(f) the first and second vent passageways are aligned to form a common vent passageway.

16. The stream-selection manifold of claim 15, further comprising:

(g) a first flow-through modular body for housing the first valve assembly, the first modular body having a first inlet port, a first outlet port, and a first vent port communicating with the first inlet passageway, first outlet passageway, and first vent passageway, respectively; and

(h) a second flow-through modular body for the second valve assembly, the second modular body having a second inlet port, a second outlet port, and a second vent port communicating with the second inlet passageway, the second outlet passageway, and the second vent passageway, respectively.

17. The stream-selection manifold of claim 15, wherein:

(g) the width of the common outlet passageway is from about six/one-hundredth's to about eight/one-hundredth's of an inch;

(h) the volume of the first and second outlet passageways is from about six/one-hundredth's to about eight/one-hundredth's of a cubic centimeter; and

(i) the C_v of the first and second valve assemblies is from about 0.04 to about 0.06.

18. The stream-selection manifold of claim 15, further comprising:

(g) first and second threaded rods;

(h) first, second, third, and fourth slots;

(i) a first pivot point, comprising the first rod disposed in the first slot, about which the first valve module can be rotated until the third slot is clear of the second threaded rod, after which the first valve module can be removed from the manifold without removing the sec-

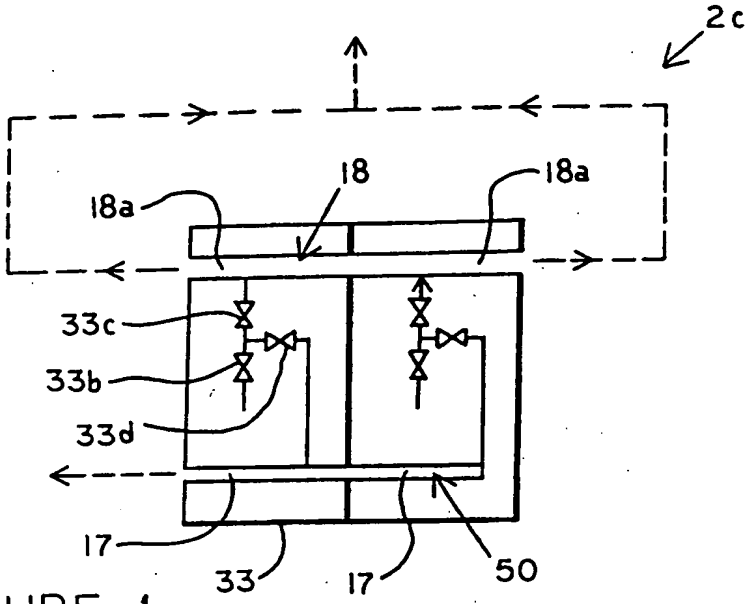

FIGURE 1

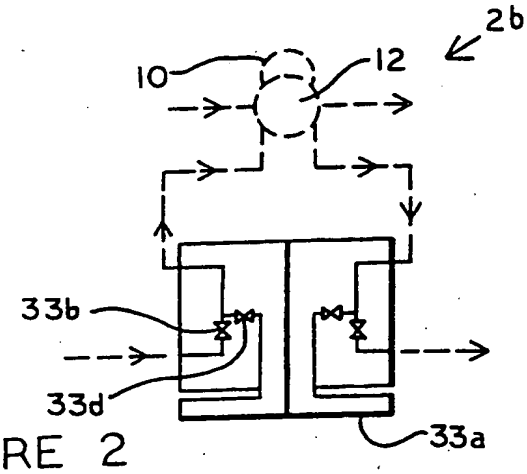

FIGURE 2

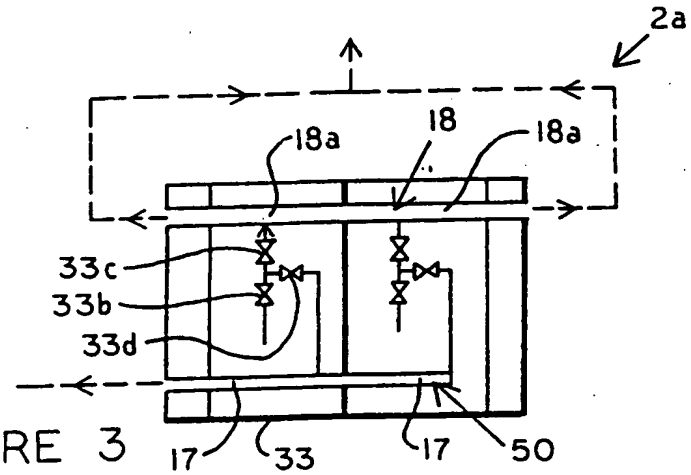

FIGURE 3

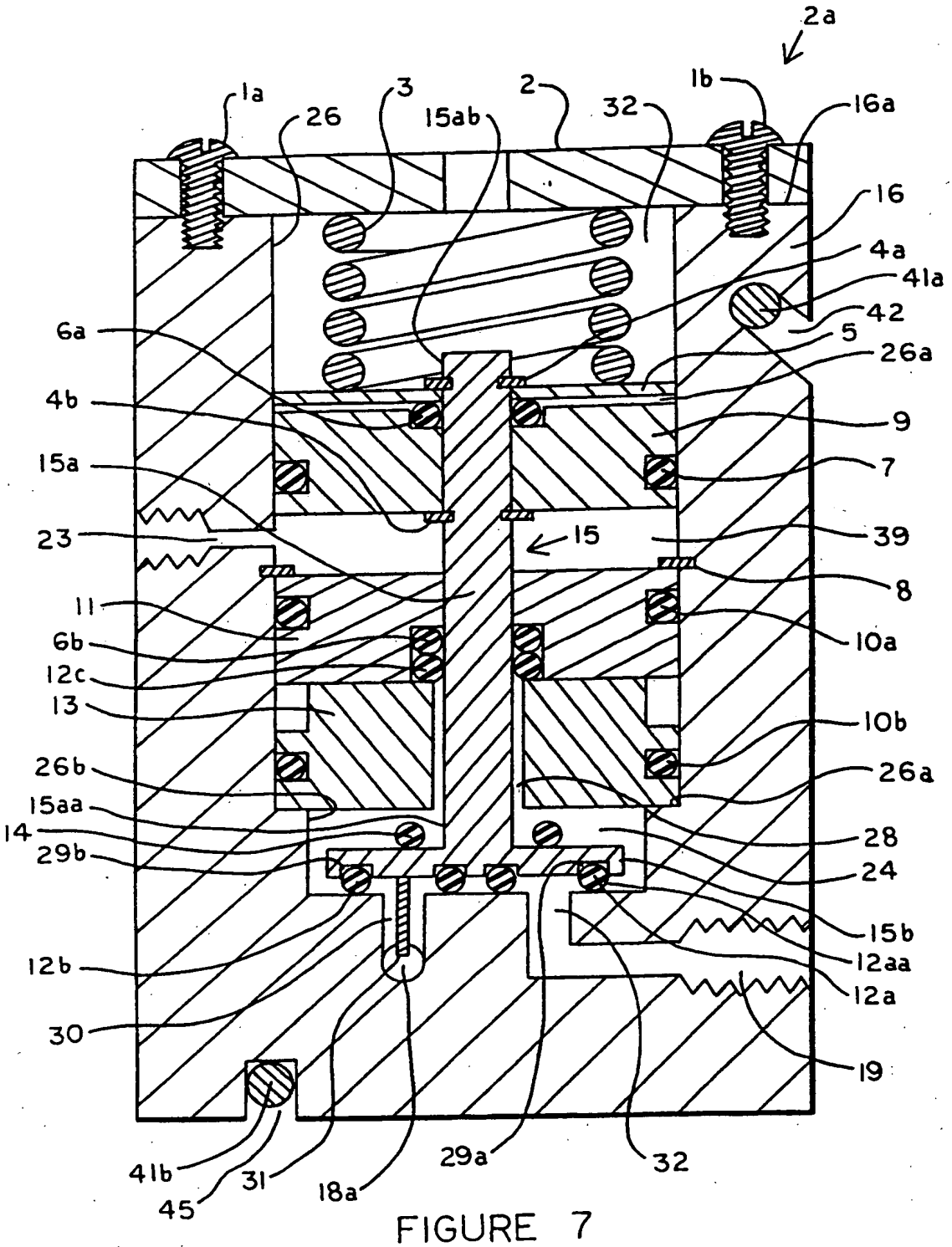

FIGURE 7

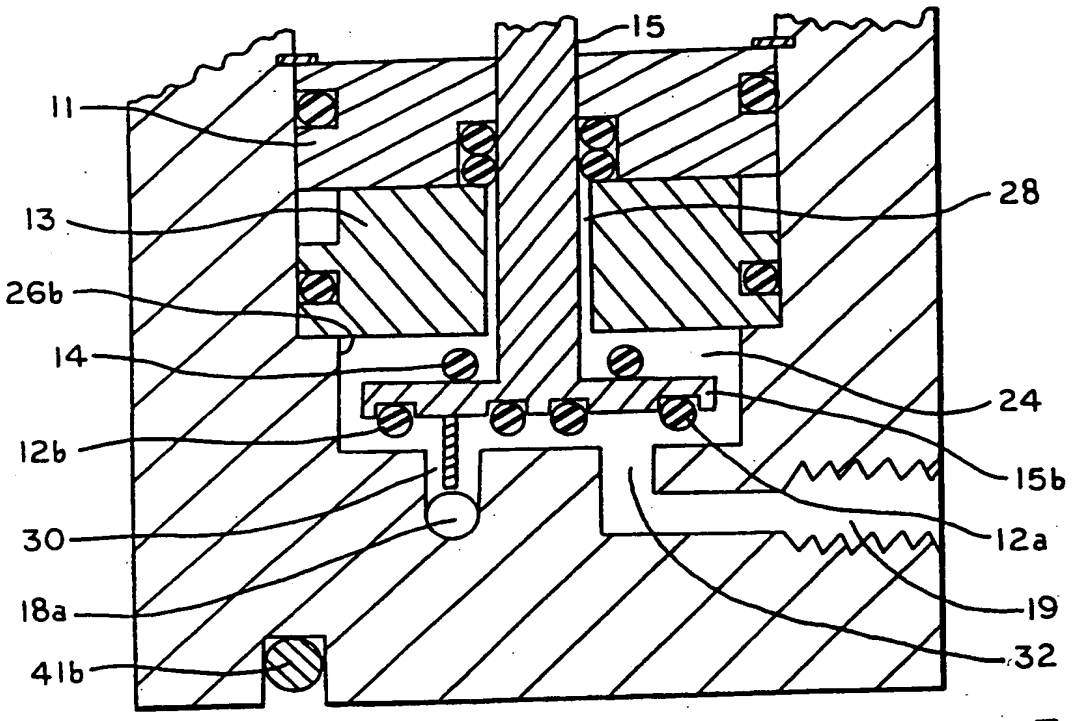

FIGURE 10

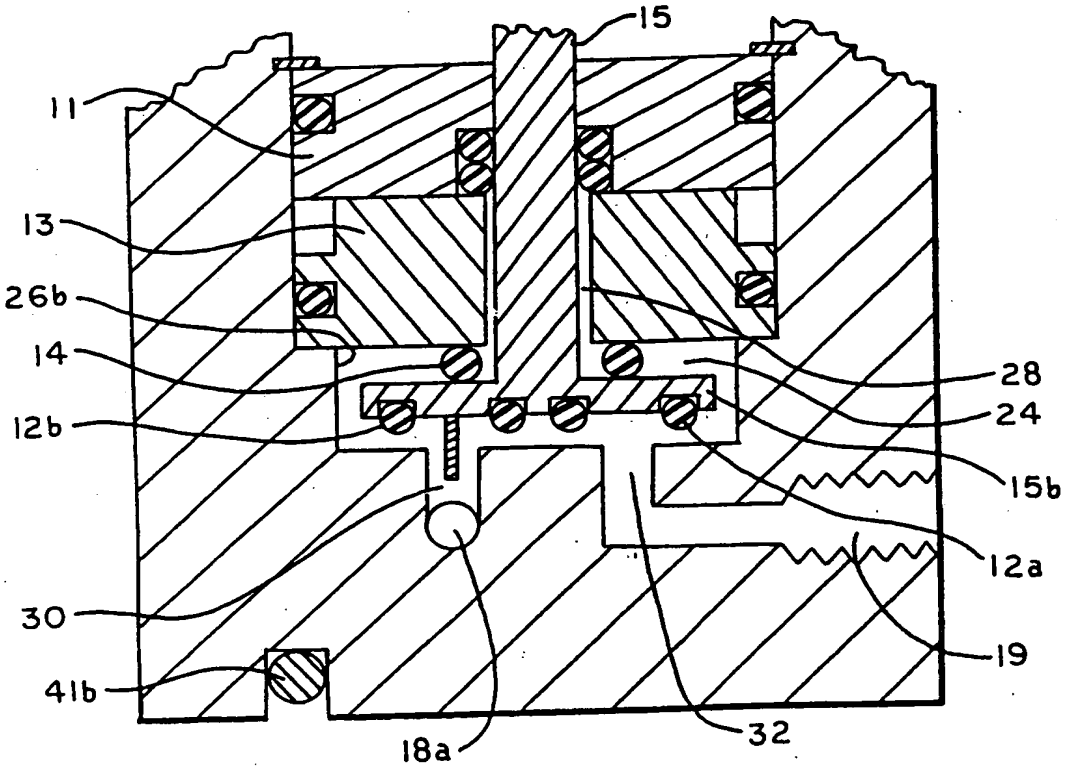

FIGURE 9

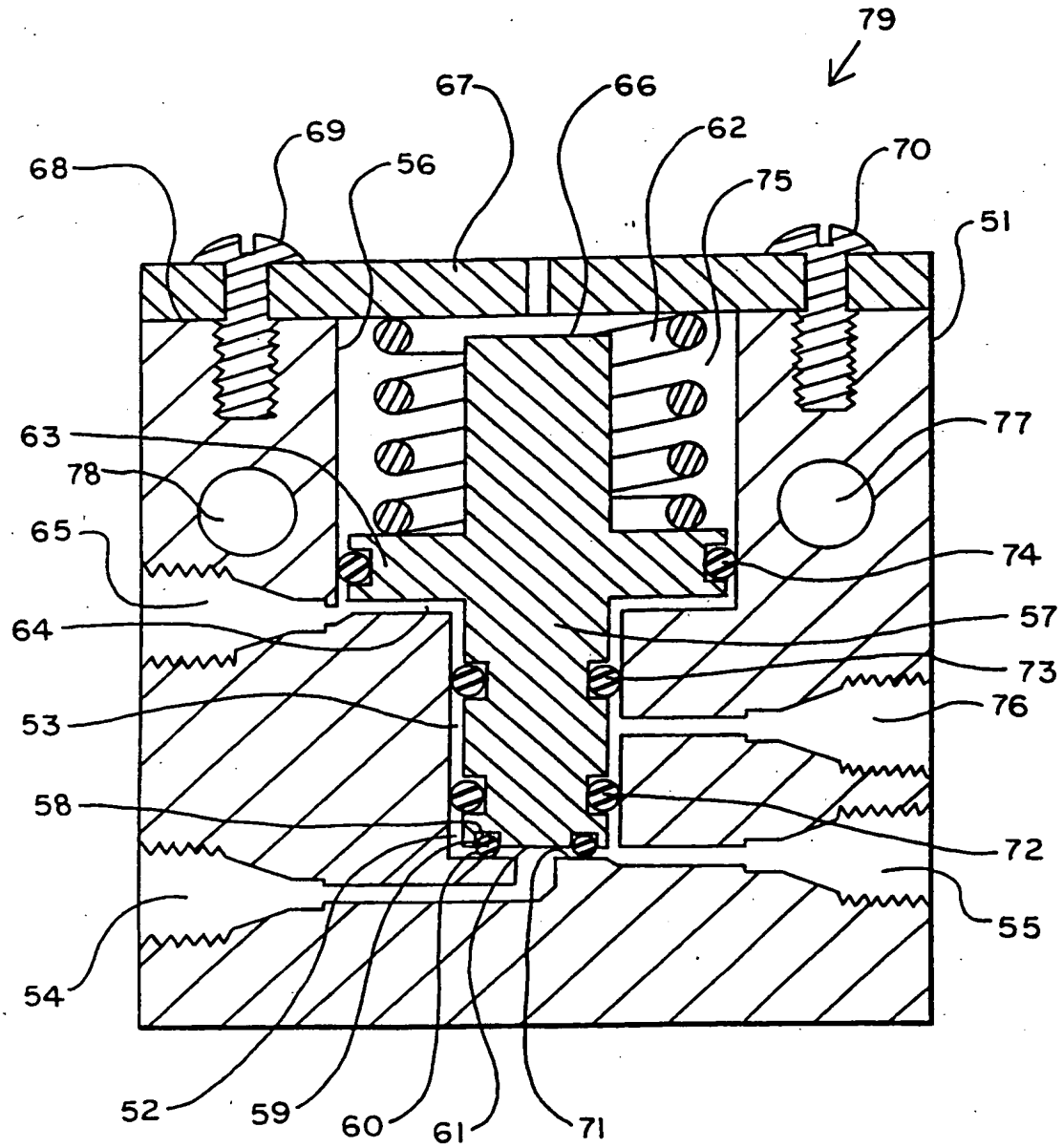

FIGURE 13

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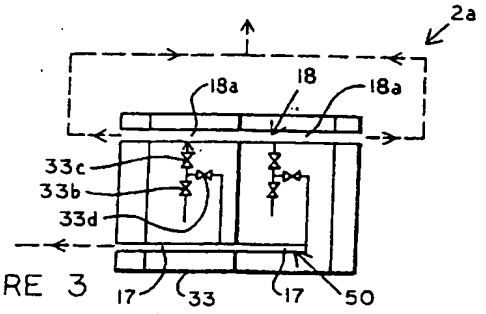

FIGURE 3

EP 0 583 166 A3

European Patent Office

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

☐ All claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for all claims.

☐ Only part of the claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid.

namely claims:

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirement of unity of invention and relates to several inventions or groups of inventions.

namely:

see sheet -B-

☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid.

namely claims:

☐ None of the further search fees has been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims.

namely claims:

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EP 93 30 6369 -B-

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirement of unity of invention and relates to several inventions or groups of inventions, namely:

1. Claims 1-18: Double bloc-and-bleed valve module, and stream-selection manifold comprising such modules

2. Claims 19,20: Single block-and-bleed valve module with internal actuator